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Chains, Links, and Loops: Towards a Deeper Understanding of the Sewing Structure in Eastern Mediterranean Bookbinding

Abstract: The sewing of a number of gatherings into a book block is the single most important process in the making of a functional codex. There are several stages and variations in the techniques used, which vary with the period and cultural context. This contribution aims to give an overview of the technicalities of the sewing used in the unsupported bookbinding traditions of the Eastern Mediterranean, which are directly related to the earliest codex structures. Issues of terminology and the relation to the techniques used in fabric making are also considered.

1 Introduction

As explained in detail elsewhere, the sewing structure of a codex is essentially the structure of a fabric.[1] The purpose of this paper is to look more closely at the sewing of manuscript books bound with unsupported sewing, primarily those following the Byzantine tradition, to enrich the existing bibliography on the subject;[2] and, wherever possible, to try to incorporate the technology, terminology and classification of textiles. The research and resulting literature in the latter fields are much larger and older than the literature on the technology, terminology and classification of bookbinding techniques.

Unsupported sewing was typical of all codices bound until the seventh to eighth centuries. From then until the eighteenth century, it was almost exclusively used in codices bound in the Eastern Mediterranean, and is still occasionally used today, mostly in book conservation studios. In the West, supported sewing structures were introduced around the eighth century; around the eighteenth century, these gradually supplanted the unsupported sewing struc-

1 Boudalis 2018, 49–68.

2 The most important contribution on the subject remains that of Guy Petherbridge from the year 1991.

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tures of post-Byzantine bookbindings, and then the remaining Eastern Mediterranean bookbinding traditions.[3]

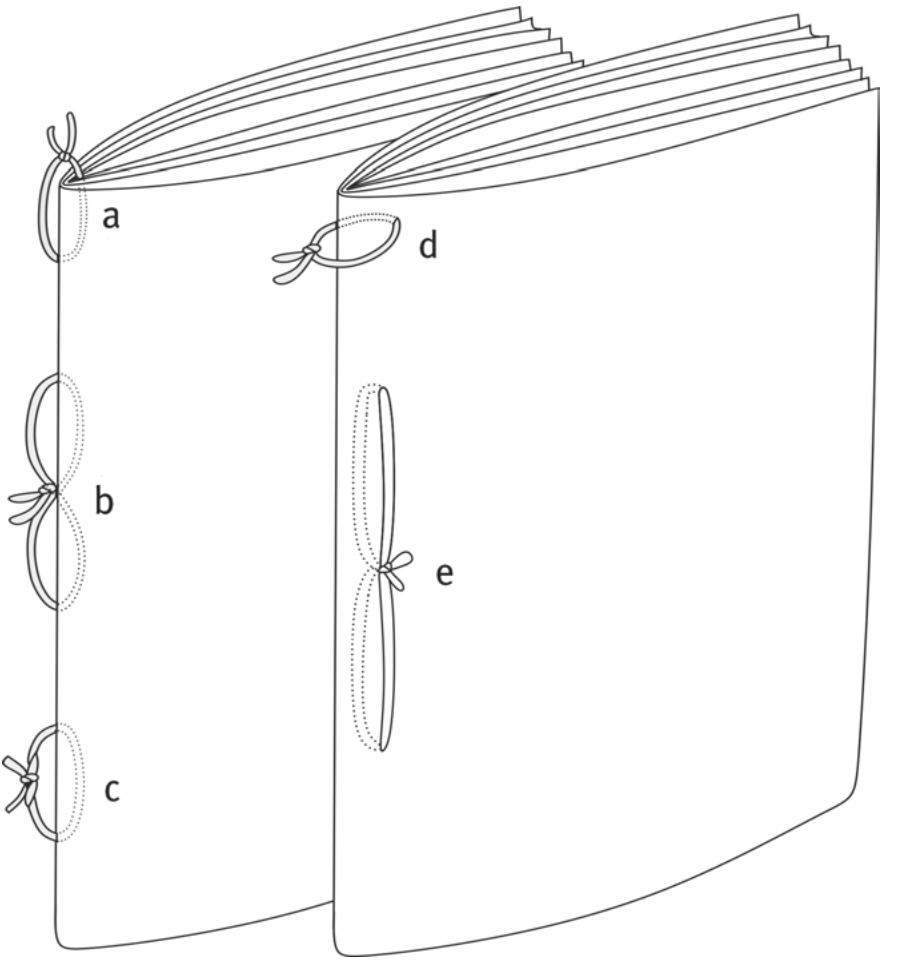


Fig. 1: Different types of tackets. Normally just one of these would have been used in a gathering. In the drawing, the knots are shown in the spine, but they can be likewise be found in the centrefold of the gathering. The tackets on the left are sewn through the fold, while those on the right are sewn through the full thickness of the gathering.

3 Boudalis 2016.

Although there are examples of book blocks sewn with unsupported sewing from Italy in the late fifteenth and sixteenth centuries, and later on from Germany and France, this type of sewing was reintroduced in the West in the eighteenth to nineteenth centuries: first most likely as a provisional way to hold the gatherings of books together as they went through the book trade, and later on as a result of machine sewing.[4]

Binding a number of gatherings into a codex was done to facilitate their use and protection. Therefore, it seems sensible to suggest that in most cases, once a manuscript was written or copied, it would have been bound soon after, unless, for one reason or another, this was not possible or posed difficulties. Nevertheless, we do have evidence of the circulation and use of manuscripts in unbound form: for example, a letter from Patriarch Gregorios to Theodora Raoulaina, written around the third quarter of the thirteenth century, in which he refers to a pair of manuscripts that he copied – one for himself, the other for Raoulaina. In the letter, he writes that he will send his copy to the bookbinder to be properly bound into a real book, and that he would be willing to do the same with the manuscript he has already given to Theodora Raoulaina in unbound form as long as she sends it back to him.[5]

2 The sewing process

2.1 Preliminary and temporary stitching

The book block of a multi-gathering codex is composed of a number of gatherings or quires, the composition and structure of which can vary. Normally they are composed of a limited number of bifolia (often four or five, in which case the resulting gatherings are called quaternions and quinions, respectively) placed one inside the other.[6] It was probably the responsibility of the scribe or the person who repaired books to mark and number the gatherings of a book block so that, once it passed to the binder (assuming that the binder was a different indi-

4 I am grateful to Nicholas Pickwoad for this information. See also Pickwoad 2000.

5 See Kotzabassi 2011 and Bianconi 2018, 95–99.

6 The literature on the composition and structure of gatherings is extensive; see, for example, Irigoin 1998. For a synthesis and recent bibliography related to the various book traditions of the Eastern Mediterranean, see Bausi et al. 2015, 79–80, 97–99, 121, 134–135, 142–144, 159, 196, 214, 241, 254–256.

vidual),[7] they would be bound in the right order. There were several ways to number the gatherings of a book block, using letters or numbers usually written on the recto of the first folio of a gathering, the verso of the last, or even both. The numbering of the gatherings was usually placed in the upper or lower margins of the folios.[8] Occasionally, it is possible to identify different numbering series on gatherings of the same manuscript, a clear indication that it was rebound.

It was presumably also the responsibility of the scribe to make sure that the bifolia of the gatherings would not be misplaced or lost on their way from the scribe to the binder, or even by the reader, assuming that in some cases book blocks would have been used for some time without being permanently bound in a codex. As pagination or foliation was almost unknown in manuscript books, this could be achieved, for example, by using gathering tackets, that is, 'a short length of flexible material used to attach one component to another by lacing it through one to four matching holes made through both components.'[9]

Gathering tackets can be of at least five different types, as shown in Fig. 1. Three of these are sewn through the spinefold (Figs 1a–c), and two through the whole thickness of the gathering (Fig. 1d).[10] These would usually be cut and removed once the gatherings were bound into a book block, but were occasionally left in place, where they can be still found today in the spinefold of gatherings in bound codices (Fig. 2). The stab sewing shown in Fig. 1e was also used

7 See, for example, the note on the last folio of codex Lisbon, Archivo de Torre do Tombo, 669, where the following note is written in Greek, obviously addressed to the binder: 'Just so you know, the gatherings (τετράδια) that Kamilos wrote (ἔγραψε) contain the Book of Numbers. So take good care to bind them together (δέσεις σωστά μαζί) with those written before'. See Harlfinger and Escobar 2008, 273. I am grateful to Elias Tsolakopoulos for bringing this to my attention.

8 The literature on the subject is extensive. For example, see Andrist 2004 and Bausi et al. 2015, 81–82. Specifically on Arabic manuscripts, see e.g. Déroche 2006; on Greek manuscripts, Mondrain 1998; and on Syriac manuscripts, Briquel Chatonnet 1998. See also Bianconi 2018, 87–88 and 90. Maybe it is worth mentioning here the case of codex Venice, Biblioteca Nazionale Marciana, gr. Z. 269 (coll. 533) (Diktyon 69740), in which the gatherings are not numbered with the typical sequence of the Greek alphabet letters but rather so that the letters used for the numbering of the gatherings form the initial verse from Psalm 103: Εὐλόγει, ἡ ψυχή μου, τὸν Κ(ύριο)ν. Κ(ύρι)ε ὁ Θεός μου. Mentioned in Bianconi 2009, 28, and n. 42.

9 See the *Language of Bindings Thesaurus*, *s.v.* 'tackets': https://www.ligatus.org.uk/lob/concept/1657. See also Gullick 1996; Gumbert 2011; and Petherbridge 1991.

10 See Petherbridge 1991, 376–378.

occasionally, mostly as a sort of informal binding for a limited number of folios or gatherings rather than as a preliminary stitching.[11]

Some of these preliminary stitches could also be used to hold together not just the leaves of a single gathering, but all the gatherings of a book block. This could be achieved, for example, with the tackets shown in Figs 1a, d and e if sewn through all the gatherings of a book block:[12] for example, in codex Athos, Monē Ibērōn, 1322 (Lambros 5442) (Diktyon 24917), a nineteenth-century *paterikon* (collection of patristic and monastic writings) that was never properly bound, i.e. the gatherings were never sewn together and the book was given no boards and no cover. Instead, the two tackets at the head and tail of each gathering were all held together with a cord wrapped around them, creating a sort of tuft at each end of the spine. At the head there is also a piece of leather inserted through these tackets as a sort of sewing support (Fig. 3).

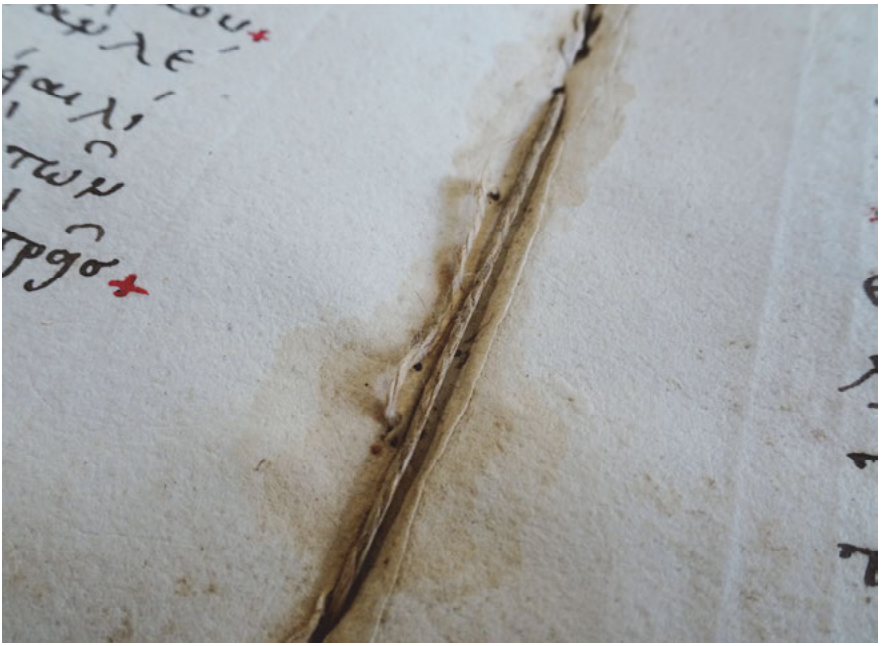


Fig. 2: The sewing thread (black arrow) and the tacket thread (red arrow) as seen in the centrefold of fols 4^{v} and 5^{r} in codex Veria, Dēmosia Kentrikē Bibliothēkē, KB 10 (detail).

11 See Petherbridge 1991, 378–379.

12 See van Regemorter 1967, p. 115, fig. 3 and Grosdidier de Matons 2008, 369–371, pl. 1–5.

Fig. 3: Athos, Monē Ibērōn, 1322, a *paterikon* written in the nineteenth century (detail).

2.2 Spinefold repair stitching

Usually, when codices were rebound, this was done not for aesthetic purposes, but rather because they had suffered some sort of damage to one or more of their component parts, i.e. the folios, boards, sewing etc. In such cases, it was common to have the spinefolds of some or all the gatherings repaired by pasting strips of paper or parchment, or very often by stitching. The presence of such spinefold stitching is unequivocal evidence of repair of the book block, normally related to the current binding of a codex; the repair can thus be dated according to the date of the binding. This sort of stitching could be also used for simple, informal 'books' like the one from the sixth or seventh century CE found in the Epiphanius monastery in Egypt (see Fig. 4).

The stitching was normally done with plain, rather thin thread, but dyed threads are also occasionally recorded, as are thin parchment strips or catgut, for example in Sinai, Monē tēs Hagias Aikaterinēs (Saint Catherine Monastery's Library), Geo. 49 (Fig. 6).[13] Although such stitching could be simply improvised, at least five consistent types have been recorded:

1. Simple overcasting. Also known as whipstitch, this stitch goes through the whole thickness of the gathering and around its spine in one direction, e.g. from head to tail (Fig. 5a).
2. V-shaped overcasting. This is essentially an overcasting performed in two directions, say from head to tail and back, so that a sequence of V-shaped stitches is formed along the spine (Fig. 5b). This can occasionally take the form of a more or less consistent X shape.
3. Running stitch. A stitch that goes through the whole thickness of the gathering parallel to the spine, in one direction, e.g. from head to tail. Although this is a very simple stitch to make, it occurs rarely in Byzantine codices, possibly because it provides no protection or reinforcement of the actual spinefold of the gathering (Fig. 5c).
4. Backstitch. This is essentially a running stitch performed in two directions, for example from head to tail and back, so that on both sides of the gathering, a continuous sequence of stitches is formed parallel to the spine, enclosing the folios on both sides (Fig. 5d). This is a rather uncommon stitching in spinefold repairs of codices. There are instances of manuscripts repaired in the twentieth century with a similar stitch, made by a sewing machine.

Sometimes different stitches were combined together, especially the different types of overcasting. The process usually started and ended with a knot, for example a stopping knot.

13 On the characteristics of the threads used for the sewing of codices and how to record them, see Petherbridge 1991, 386–391.

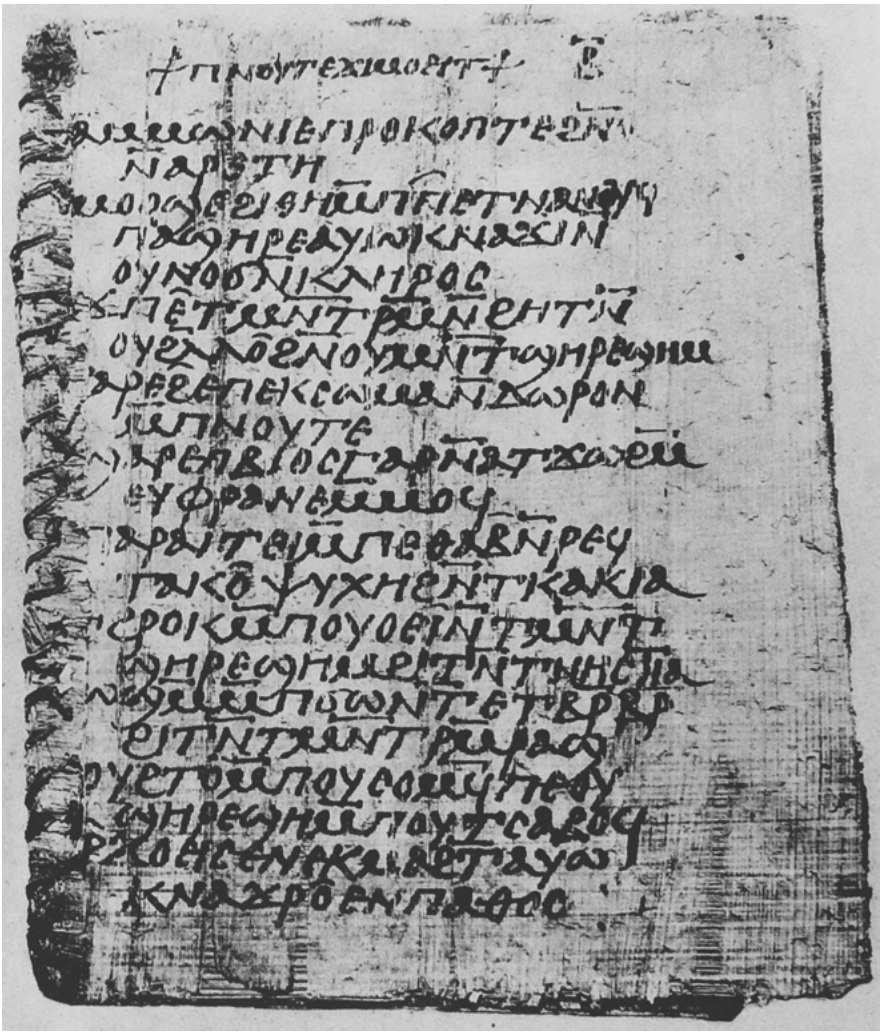


Fig. 4: A codex of eight single leaves sewn with overcasting, found in the monastery of Epiphanius in Egypt, dated to the sixth or seventh century CE; Winlock 1926, vol. 2, pl. 4 (no. 592).

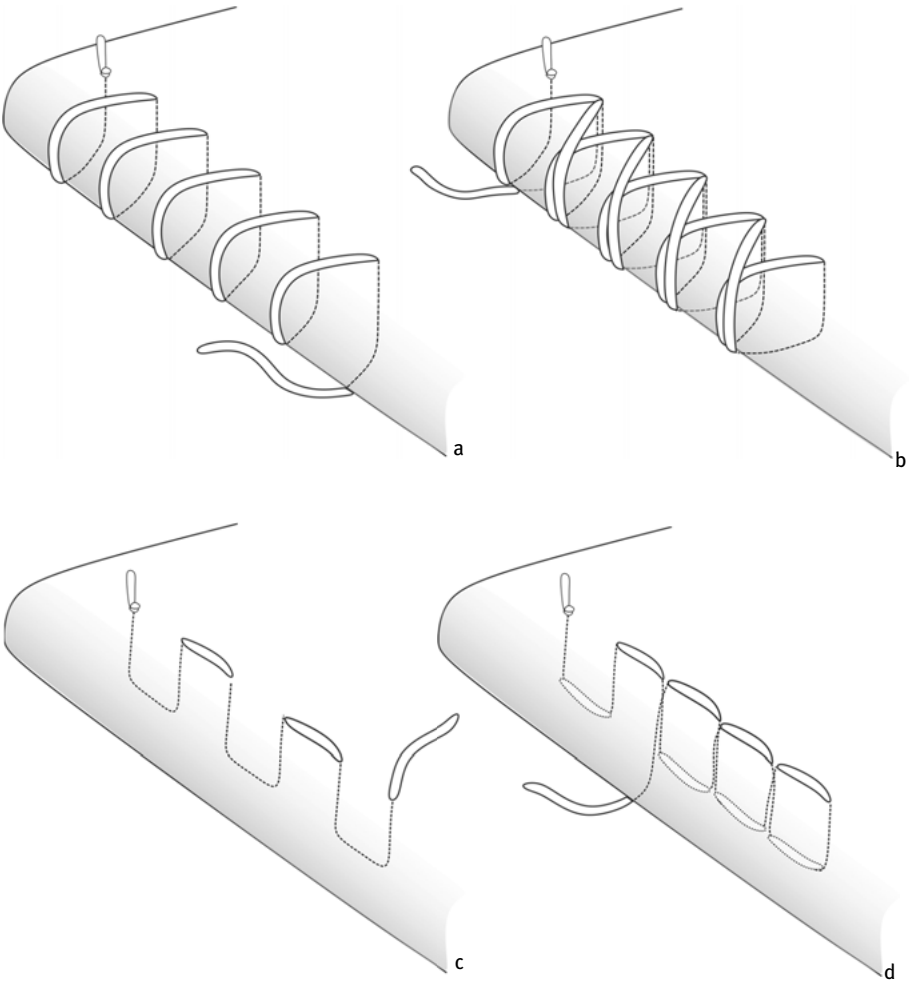


Fig. 5a–d: Five different types of spinefold repair stitching: (a) simple overcasting, (b) V-shaped overcasting, (c) running stitch and (d) backstitch.

a b c

Fig. 6a–c: Gatherings of the same codex, Sinai, Monē tēs Hagias Aikaterinēs, Geo. 49 (details), with their spines repaired with different types of stitching: V-shaped overcasting (a), running stitch (a, b) and backstitch (b). These are used to hold together single reused palimpsest folios, as can be seen in gatherings three to six from the top in (c).

2.3 The arrangement of the sewing stations

Once all the gatherings of a book block were on the bookbinder's bench ready to be sewn together into a codex, the first thing to do would be to mark the sewing stations along the spinefolds. Sewing stations can be divided into main sewing stations and change-over stations; the latter are the ones where the sewing thread proceeds from one gathering to the other.[14] As a rule, the sewing stations are distributed along the spine in a symmetrical way, and the ensuing rectangles that form between the head and tail edges of the book block, the change-over stations and the main sewing stations are called sewing panels. The relations between the outermost panels and those in between the change-over stations yield four different arrangement patterns:[15]

1. The arrangement where all the panels are of the same width. This arrangement is not affected by the total number of sewing stations used on a book block (Fig. 7a).
2. The arrangement where the outermost panels (shown in red) are narrower than their adjacent ones (shown in yellow, blue and green). This arrangement is affected by the number of sewing stations used, and therefore a number of variations can be observed (Fig. 7b; from top to bottom, two, three, four, five and six sewing stations).
3. The arrangement where the outermost panels (shown in red) are wider than their adjacent ones (shown in yellow, blue and green). This arrangement is also affected by the total number of sewing stations, and similarly there are a number of variations (Fig. 7c; from top to bottom, two, three, four, five and six sewing stations).
4. The arrangement where no clear symmetry or pattern can be identified. This is a very rare option, found in bindings of very low standards.

It would seem that some arrangements are typical of specific periods, binding ateliers or even individual binders. Most of the Byzantine bindings follow the type B arrangement, with only a few recorded examples of types A and C. The latter seems to become more common with the gradual adoption of sewing supports and the consequent rise in the number of sewing stations.[16]

14 See Spitzmueller 1982–1983.

15 On this, see also Petherbridge 1991, 400–404.

16 See Boudalis 2004, 335–336.

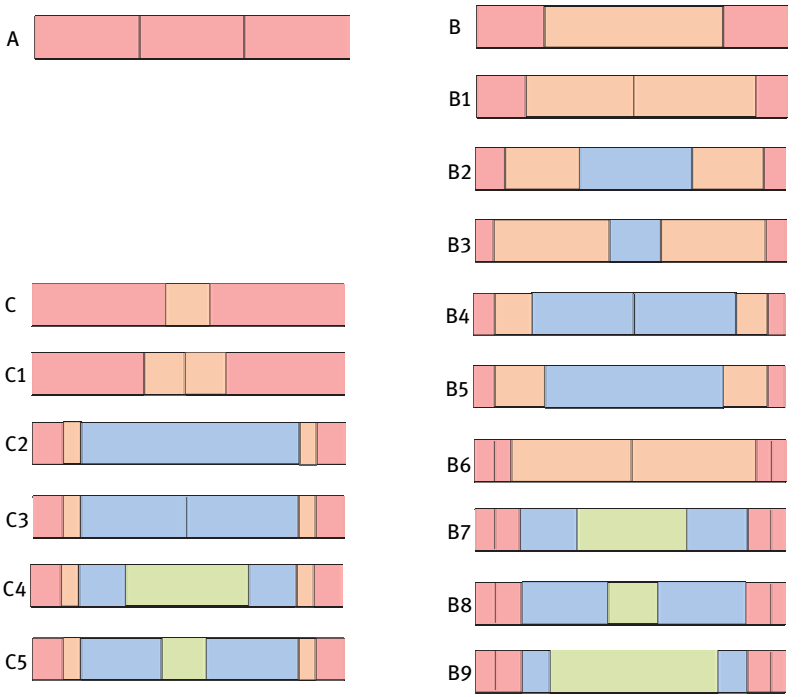


Fig. 7: From left to right, panel arrangements of types A, B and C, with differences within each based on the number of sewing stations used.

2.4 The opening of V-shaped cuts

An almost ubiquitous feature of Byzantine bindings is the V-shaped cuts opened in the spines of the gatherings corresponding to the sewing stations. These are used in order to facilitate the passage of the sewing thread through the gatherings and recess the bulk of the 'chains' that result from the sewing process, allowing the spine of the volume to remain smooth (Fig. 8). They were most likely opened before the start of the sewing process, once the arrangement of the sewing stations was decided, and have been somehow marked along the spine of the gatherings, possibly with graphite or with just a pointed or sharp tool.

V-shaped cuts are a typical feature of Byzantine bookbindings, but they are not equally common in other binding traditions, like the Syriac or the Islamic ones, in which simple needle holes were used (Figs 9 and 10). In the Islamic

tradition, the absence of V-shaped cuts is certainly due to the thin threads used for the sewing of the book block gatherings. It is interesting to note that once the thread passes through a simply cut sewing station and pulled, it will somehow open it and give it a sort of V-shaped form. V-shaped cuts and recesses were a common feature in wax tablet codices, used for keeping the sewing thread in place as well as recessing and protecting it.[17]

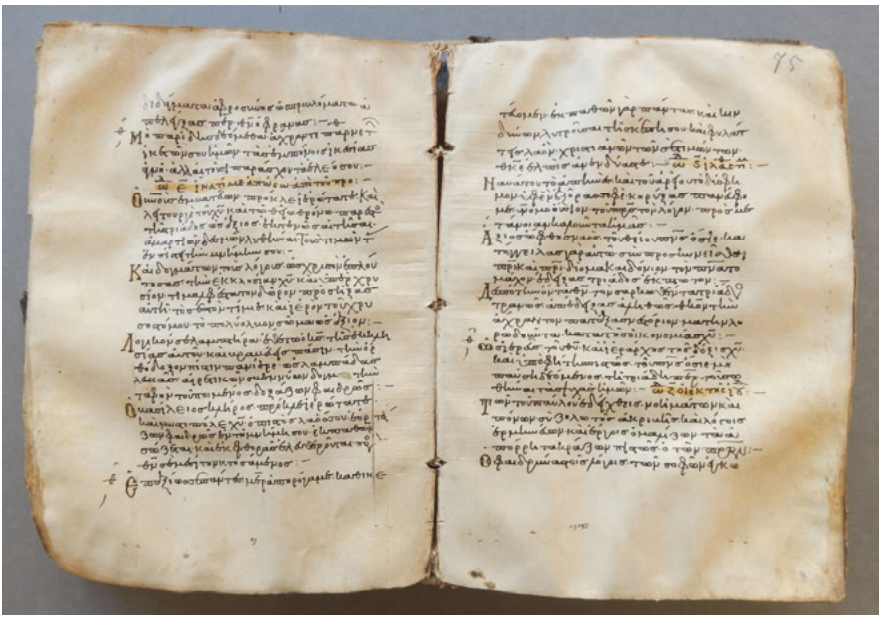


Fig. 8: The V-shaped cuts of the three main sewing stations in codex Sinai, Monē tēs Hagias Aikaterinēs, Gr. 566 (Diktyon 58941), fols 74ᵛ–75ʳ; the change-over stations have only straight cuts; courtesy of the Saint Catherine's Monastery on Mount Sinai.

17 Boudalis 2018, 27, fig. 12.

Fig. 9: The sewing holes in the five sewing stations of codex Sinai, Monē tēs Hagias Aikaterinēs, Ar. NF 28.

Fig. 10: The sewing holes of the six sewing stations of codex Sinai Monē tēs Hagias Aikaterinēs, Gr. 211 (Diktyon 58586).

There are also a few examples where, instead of a V shape, the cuts are clearly U- or Π-shaped (according to whether the angles are rounded or not). An example of the former is codex Brussels, KBR, 11344 (Diktyon 9953), a Greek manuscript bound in Italy sometime in the second half of the fifteenth century, in an imitation Byzantine binding also known as 'alla greca'[18] (Fig. 11); an example of the latter is codex Sinai, Monē tēs Hagias Aikaterinēs, Gr. 1775 (Diktyon 60150), probably also written and bound in Italy in the seventeenth century, before 1661 (Fig. 12).

18 On the binding of this codex, see Boudalis and Gialdini 2022.

Fig. 11: The U-shaped openings used in the sewing stations of codex Brussels, KBR, 11344. Notice the crossing scored lines marking the board lacing station.

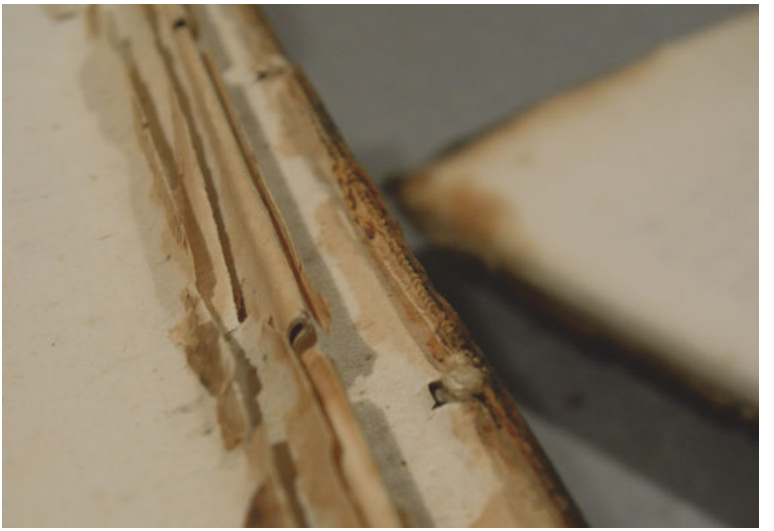


Fig. 12: The Π-shaped openings used in the sewing stations of codex Sinai, Monē tēs Hagias Aikaterinēs, Gr. 1775.

There seem to have been at least two options for the opening of these V-shaped cuts:

1. Two-step V-shaped cuts. Two converging cuts were performed at an angle forming a V. There are several examples in which one or both cuts can be seen extending beyond the apex of the V. The angle of the V is usually around 60 degrees (Fig. 14a).
2. Three-step V-shaped cuts. Instead of two converging cuts, one could make a straight cut exactly at the sewing station point, perpendicular to the spine-fold of the gathering. Consequently, using that cut as a guide, two lateral converging cuts could be made, both meeting at the vertical cut (Fig. 14b). Using this method, one can easily control both the depth of the V-shaped cut as well as the consistency of the cut angle. There are a few examples of codices with knife cuts along the spine of their book blocks, which seem never to have been used and can be understood as simple cuts that for some reason were abandoned before being turned into V-shaped cuts (Fig. 13).[19] One example of this practice is evident in the gatherings of Los Angeles, The J. Paul Getty Museum, Ms. Ludwig II.5 (83.MB.69) (Diktyon 39946), where in most of the V-shaped cuts one can see a small vertical cut extending from the apex of the V.[20] Of course, in this case, three cuts rather than two are required for each opening, which somehow increases the amount of time and effort required.

The vertical cut could also be made in all the gatherings in one go with a knife while the book block was secured in a wooden press, spine facing up. In this case, it could be understood both as a marking for the sewing stations and the first step towards the opening of the V-shaped cuts.

19 Examples of this practice can be seen in the codex Athens, Ethnikē Bibliothēkē tēs Hellados, 67 (Diktyon 2363); Sinai, Monē tēs Hagias Aikaterinēs, Gr. 1218 (Diktyon 59593) (Fig. 13); and Oxford, Magdalen College, gr. 1 (Diktyon 48694). The latter contains Saint John Chrysostom, *Commentary on Gospel of John*, written on parchment in the eleventh century (I am grateful to Jane Eagan for the information provided).

20 I am grateful to Nancy Turner for putting this manuscript to my attention while at the Getty Research Institute.

Fig. 13: The spine of codex Sinai, Monē tēs Hagias Aikaterinēs, Gr. 1218. Besides the sewing recessed in the V-shaped openings, marking the three main sewing stations, two cuts that have never been used can be seen in all the gatherings between the change-over stations and main sewing stations.

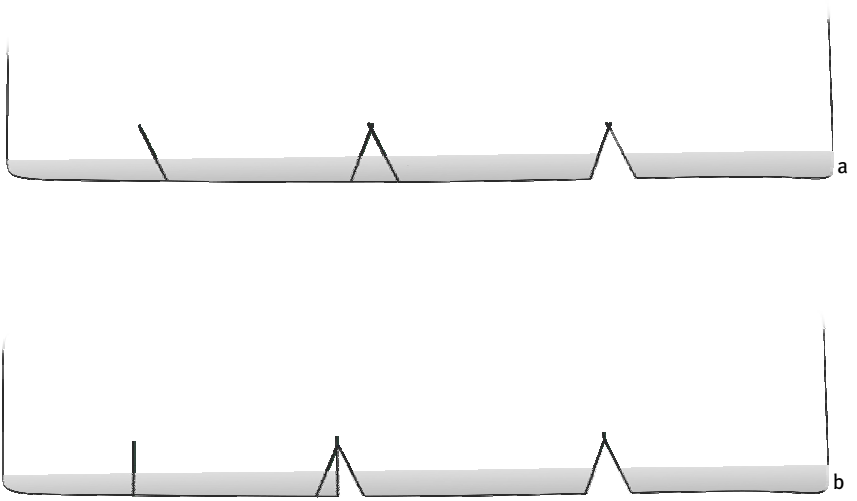


Fig. 14a–b: Two-step V-shaped openings (top) and three-step V-shaped openings (bottom).

In either case, the V-shaped cuts could have been opened on each gathering, either individually or, alternatively, in several gatherings simultaneously, perhaps while placed under weights. The perfectly aligned cuts in, for example, codex Sinai, Monē tēs Hagias Aikaterinēs, Ar. 314 are probably evidence of such a method (Fig. 15).

Fig. 15: The V-shaped cuts in one of the sewing stations in codex Sinai, Monē tēs Hagias Aikaterinēs, Ar. 314. The 'chains' formed by the sewing are recessed within the grooves created by these openings under the textile spine lining.

2.5 The actual sewing and its variations

Once the sewing stations were marked and the V-shaped openings cut, it was time to proceed with the actual sewing of the gatherings, which structurally is the single most important operation in the binding procedure.[21] Generally, the process could be started in either of two ways: one is to start the sewing from the board and continue with the gatherings in a single, continuous process; the other is to complete the sewing of the gatherings of a book block first, and subsequently to attach the boards on the already sewn book block.[22] In both cases, the sewing of the gatherings and their connection to the boards is greatly improved by the adhesion of the spine lining (which covers the spine and extends

21 On this, see Petherbridge 1991; Grosdidier de Matons and Hoffman 1998; and Szirmai 1999.
22 A third possibility, proposed by Federici and Houlis (1988, 25, fig. 17), is just conjectural, as neither the authors nor any other scholars offer a specific example.

to the outer face of the boards), the sewing of the endbands (which, as a rule, extend over the edges of the boards and are sewn onto them),[23] and the adhesion of the leather or textile cover.

Both sewing options mentioned above have a few variations, and it is often difficult to decide if one or the other has been used in a specific codex, unless the quality of the thread used for the sewing of the book block is clearly visible and different from that used to connect the boards to it. It is only in those instances when a book is undergoing conservation treatment – and there is both access to the details of the binding as well as time to notice and record them – that one has a greater chance to identify the exact sewing method used. In fact, the examples presented below are both from codices that were repaired by the author in the conservation studio.

2.5.1 Sewing the boards and the gatherings in the same process

In this technique, the sewing starts from one board and proceeds to the gatherings. There any many variations on this basic technique, which is exemplified here by the sewing of codex Veria, Dēmosia Kentrikē Bibliothēkē (Central Public Library), KB 9 (Politis 4) (Diktyon 9605) , a fourteenth-century lectionary written on paper, with a fifteenth-/sixteenth-century binding, shown in Fig. 16. In this example, the sewing starts with a stopping knot at point A. From there, and through diagonal channels opened through the board between the board attachment holes marked with an * and the spine edge of the board, the thread follows the route to point B (Fig. 16-I). The process is repeated in alternating directions to points C and E (Fig. 16-II through IV), where it continues into the centrefold of the first gathering, entering at point F (Fig. 16-V). From then on, the sewing thread exits from each of the sewing stations, drops down and loops around the board until the change-over stations at point G, at which point it enters the second gathering and the process is repeated in the opposite direction (Fig. 16-VI). At the end of the process, the inner face of the board bears no signs of threads, holes or channelling, while, in the outer face of the board, there is a groove connecting all board attachment holes parallel to the spine in which the sewing thread is recessed. These channels are subsequently covered

23 There are two exceptions within the broad category of Eastern Mediterranean bookbindings: the Islamic and Ethiopic bookbindings in which the endbands do not extend to and are not sewn through the boards.

with the extensions of the textile spine lining and the cover of the volume, thus usually leaving no sign of their presence in the completed binding.

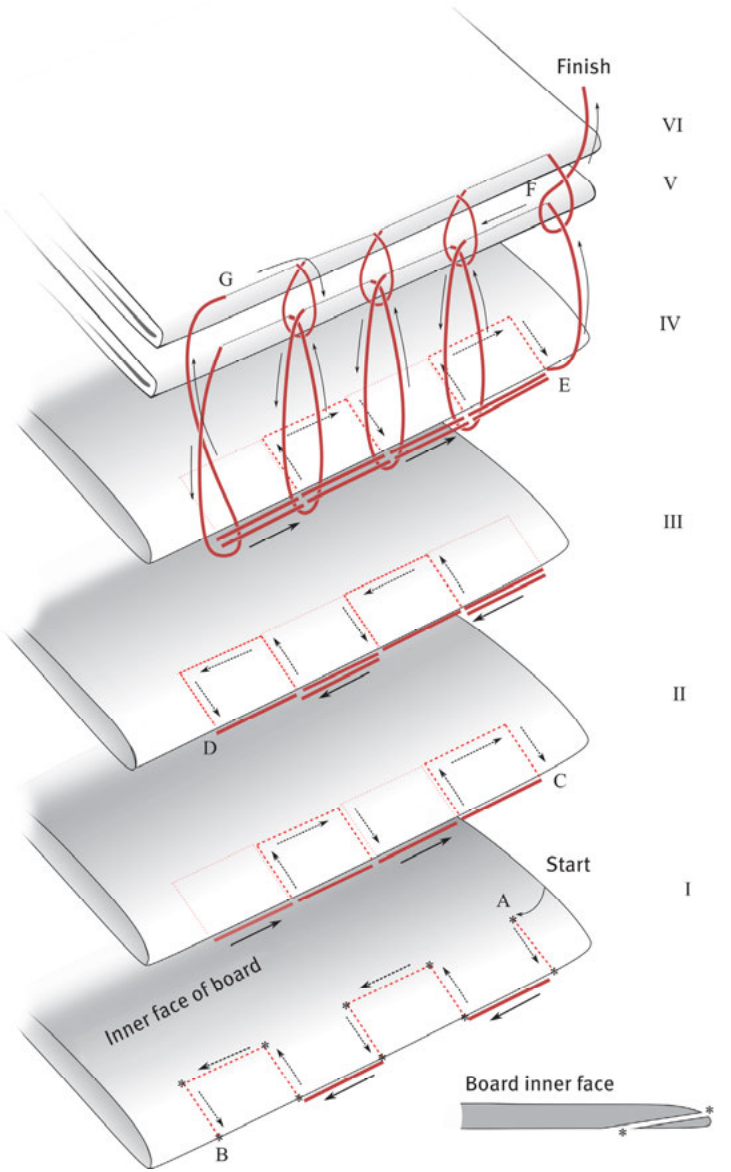


Fig. 16: The sewing of codex Veria, Dēmosia Kentrikē Bibliothēkē, KB 9.

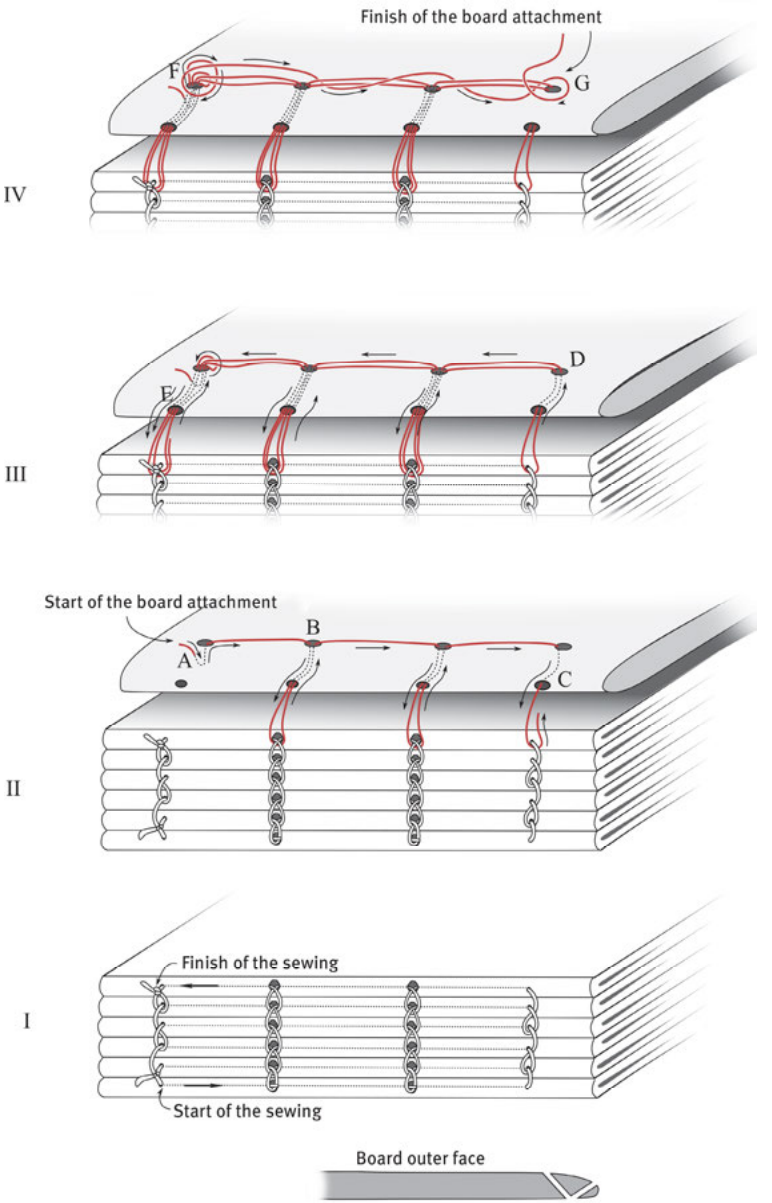


Fig. 17: The sewing of codex Thessaloniki, Aristoteleio Panepistēmion, Spoudastērion Philologikēs Scholēs, 47.

2.5.2 Sewing the book block and subsequently sewing the two boards on

In this technique, the gatherings of the book block are first sewn to form a completed book block and, subsequently, the two boards are attached to it in a different process using a different length of thread, usually of the same quality as the one used for the sewing of the book block, often making the identification of the technique very challenging if not impossible. There are also a few variations on this technique, mostly related to the pattern formed by the thread and the grooves opened to recess it into the surface of the boards. This technique is exemplified here by the Thessaloniki codex Aristoteleio Panepistēmion (Aristotle University), Spoudastērion Philologikēs Scholēs (College of Philological Studies), 47 (Diktyon 63284) [the collection of manuscripts in the Spoudastērion Philologikēs Scholēs is now in the Rare Books Department of the Aristotle University Central Library] (Fig. 17).

The process starts with the thread being passed from the outer face of the board to the inner face and blocked with a stopping knot at point A (Fig. 17-II). From there, it exits the outer face through V-shaped tunnels opened through the boards (see the cross-section of the board in Fig. 17-I), then moves to the next board attachment station in point B (Fig. 17-II), where it enters and exits through the V-shaped tunnel in order to loop around the sewing of the book block. It then re-enters the board and proceeds to the next board attachment station, repeating the process until point C, where it re-enters the board, exiting at D. From that point, the exact same process is repeated in the opposite direction, until the last board attachment station in point E (Fig. 17-III), where the thread loops to the change-over station of the book block and re-enters the same board attachment tunnel, exiting at point F (Fig. 17-IV). From there, the thread moves in the opposite direction, winding around itself until point G, where it is knotted. There are channels worked into the outer face of the wooden boards, between the board attachment holes, into which the thread is recessed so that once the boards are covered with the extensions of the textile spine lining and the cover, there is no sign of their presence.

In both these examples, the pattern formed parallel to the spine edge of the board by the thread route is a continuous ITTTTI, although it is equally common to have a continuous I\I\I\I pattern instead.[24]

24 See, for example, van Regemorter 1967, p. 20, fig. 7 and Szirmai 1999, 72, fig. 6.6.

2.6 Single- and double-sequence sewing

The sewing of the gatherings of a book block in the Byzantine bookbinding tradition could be done in one single go or two halves.

The simplest technique, and in fact the one that is typical in all bookbinding traditions of the codex book format, is the one that starts from one end of the book block and ends at the other: for example, from the first gathering to the last, or vice versa. This can be done in both of the ways described above, i.e. by starting and finishing the sewing to and from the boards, or simply by sewing the gatherings of a book block and subsequently attaching the boards to it. If the spine of the book block is visible, this sewing technique can be identified by the fact that the 'chains' formed in the process all point in the same direction, either >>>>>>>>>>>> or <<<<<<<<<<<<, according to the direction in which the gatherings were sewn together, considering that the pointed end of the 'chain' indicates the direction of sewing (Fig. 18).

Fig. 18: Single-sequence sewing in codex Sinai, Monē tēs Hagias Aikaterinēs, Gr. 34 (Diktyon 58409).

The other option is to sew the gatherings of a book block in two halves, a particular technique that is in fact very common in Byzantine bookbindings, but not in the other Eastern Mediterranean traditions, like Syriac, Arabic, Coptic etc. Nevertheless, in the Sinai library, there are examples of double-sequence sewn book blocks among the Arabic and the Syriac manuscripts, but these seem to be the product of the amalgamation of binding techniques reflecting the multicultural and multilingual environment of Sinai.

The first to identify double-sequence sewing was Petherbridge, in a paper delivered in 1983 and published in 1991.[25] The technique consists in sewing the gatherings of a book block in two halves, which at the end are connected with the sewing thread performing a sort of figure-eight, looping around the sewing stations of the two halves.[26] The thread is usually quite visible along the spine of the gatherings between the sewing stations as it moves from one sewing station to the other. Besides the thread, which connects the sewing stations at the point where the two halves are connected and which usually runs more or less parallel to the spine, the clearest sign of the use of this technique is the contrasting direction of the 'chains' formed in the process, in a configuration of contrasting angled brackets (Fig. 19):

>>>>>>> <<<<<<.

Fig. 19: Double-sequence sewing in codex Sinai, Monē tēs Hagias Aikaterinēs, Gr. 1205 (Diktyon 59580).

Remarkably, the same pattern is used as a decorative frieze in a marble panel from the thirteenth century, now at the Metropolitan Museum of Arts (Fig. 20). The only advantage of this technique seems to be the possibility to create the exact same rounding of the gatherings at the spine edge of the two boards, and therefore to create a consistent and symmetrical rounding of the spine of the bound codex without any hammering or other processes. This technique always seems to be employed together with the sewing of a book block that starts with

25 Petherbridge (1991, 398–399) called this *biaxial stitch disposition.*
26 See Szirmai 1999, 68, 69, fig. 6.4.

the boards (as in the example of codex Veria, Dēmosia Kentrikē Bibliothēkē, KB 9 above), as this in fact creates the symmetrical and consistent rounding in the spine.

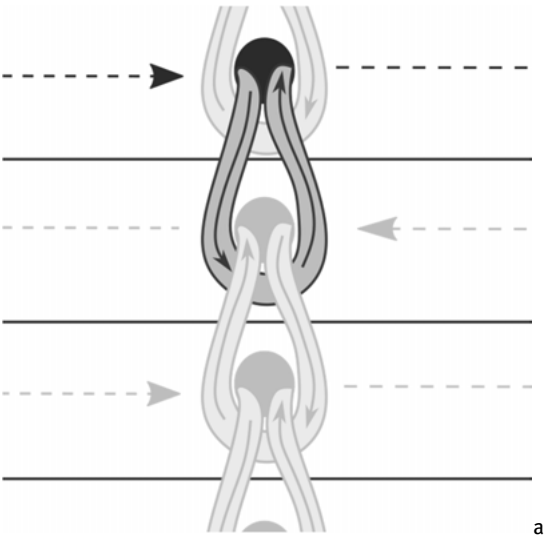
Fig. 20: Byzantine marble panel with a griffin, around 1250–1300, possibly made in Greece or the Balkans. New York, Metropolitan Museum of Art, accession number 2000.81; courtesy of the Metropolitan Museum of Art.

2.7 The different types of stitches

Unsupported sewing structures rely on a specific type of stitch that has variably been called a link-stitch or chain-stitch, but which, for reasons explained below, will here be called a linked-loop stitch. This stitch, and the technique by which it is applied in the sewing of books, is an adaptation of an ancient technique called cross-knit looping or nalbinding, used at least since Roman and Late Antiquity times to make everyday cloth items such as socks.[27] In all cases, the pointed end of the loop indicates the direction of the sewing. There are a few variations on this basic technique.

2.7.1 Open linked-loop stitch

This stitch consists in the looping of the sewing thread around the loops of the previous gathering sewing, as shown in Fig. 21a. It works better with simple needle holes in the sewing stations rather than V-shaped cuts, since the loop thus formed takes the width of the opening through which the thread passes: V-shaped cuts result in wide open loops, while needle holes result in tight open loops, which in fact work better. This type of unsupported stitch has not been described before, and so far has been identified only in Syriac bindings (Figs 21b and 21c).



a

27 See Boudalis 2018, 54–59.

b

c

Fig. 21a–c: Diagram of open linked-loop stitch (a), with two examples as recorded in codex Sinai, Monē tēs Hagias Aikaterinēs, Syr. 44 (b) and Manchester, John Rylands University Library, syr. 57 (c).

2.7.2 Crossed linked-loop stitch

This is the typical stitch used in unsupported sewn book structures, and can work equally well with sewing stations that are merely pierced or those opened with V-shaped cuts (Fig. 22c). Two options are possible, as shown in Figs 22a and 22b. In the former, called 'variation a', the thread exits from the sewing station opening (here shown as simple holes for clarity) – moving, say, from left

to right – drops, loops around the sewing in the previous gathering, climbs and enters the same sewing station opening by passing *above* itself (Fig. 22a). In 'variation b', the thread exits, loops around the previous gathering sewing, climbs and enters the same sewing station opening, but this time passing *under* itself (Fig. 22b). This second option creates a much more compact, tight and stable sewing, as the thread is somehow locked in place in the process. So far it has not been possible to identify the use of one or the other variation in any bound codex. The only way to be able to distinguish one variation from the other is to have visual access to the sewing in the spine of a book block and, most importantly, to know the direction of the sewing for a given gathering.

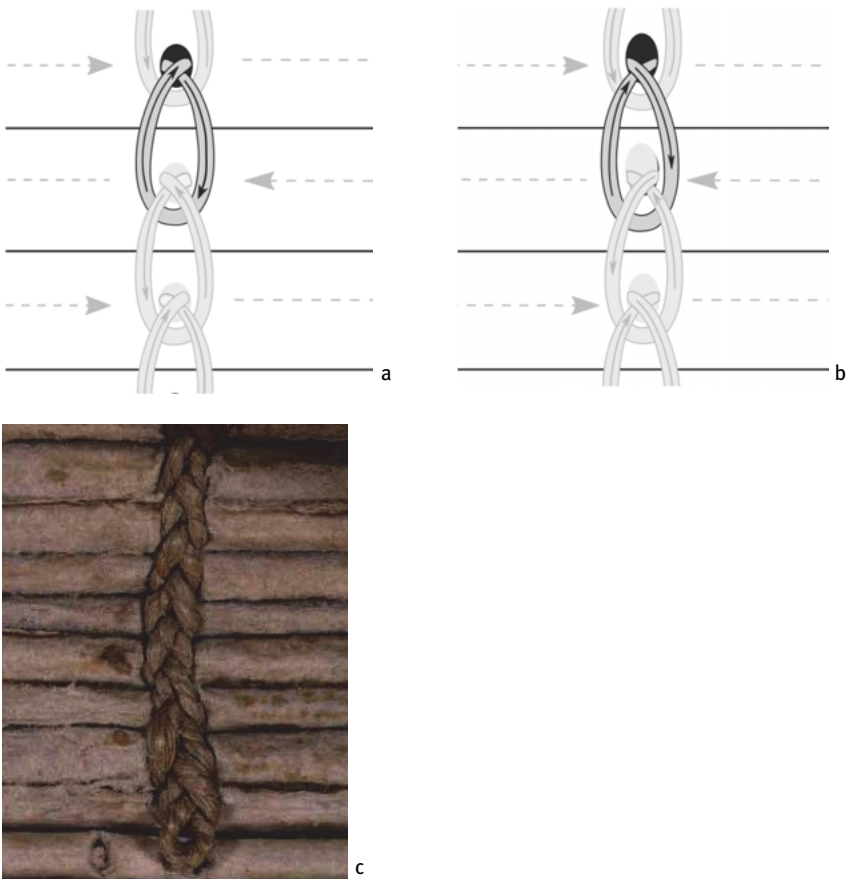


Fig. 22a–c: Diagrams of crossed linked-loop stitch: variation a (a), variation b (b), and an example as recorded in codex Sinai, Monē tēs Hagias Aikaterinēs, Gr. 824 (Diktyon 59199) (c).

2.7.3 Double-crossed linked-loop stitch

In this variation, the thread exits, loops around the previous gathering sewing, climbs and enters the same sewing station after crossing itself twice, as shown in Fig. 23. This is illustrated extensively in Theodore C. Petersen's book,[28] but the author provides no specific examples where he has identified this stitch, a fact rightly noted by Janos Szirmai.[29] The author of this article also knows of no specific example of this stitch, and therefore the question of whether it was actually ever used remains an open one.

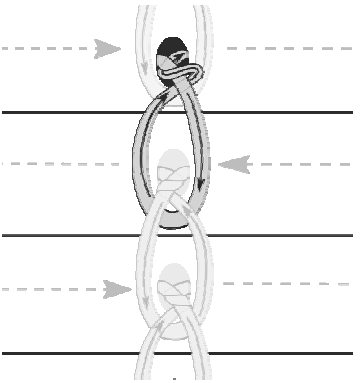


Fig. 23: Diagram of double-crossed linked-loop stitch.

The open linked-loop stitch is less bulky compared to the crossed linked-loop stitch, as in the latter, the crossing of the thread indeed doubles the thickness of the 'chains' formed in the process. For the same reason, the double-crossed linked-loop stitch is bulkier than the crossed linked-loop stitch. The thickness of the resulting 'chains' further increases with the use of the extended linked-loop stitch, i.e. linked-loop stitches that loop around the sewing of the penultimate gathering (Fig. 24) or the one before.[30] As the sewing on these bindings is often done with rather thick hemp or linen threads, the resulting 'chains' can be ra-

28 Petersen 2021, figs 12a–b, 13a–b, 14a–b, 15, 16a–b, 17.

29 Szirmai 1999, 16–17, 33, fig. 2.1.β.

30 Szirmai 1999, 16–17, fig. 2.1.a, c, d. Here they are called two-step, three-step etc. link-stitches.

ther thick, and therefore the presence of V-shaped cuts in the sewing stations allows them to be recessed and the spine of the book to remain smooth.[31]

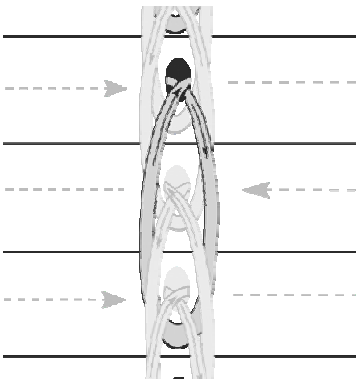


Fig. 24: Diagram of two-step linked-loop stitch.

There are also a few variations in the sewing at the change-over stations, where the thread passes from one gathering to the next.

2.7.4 Bridge

This describes the movement of the thread from one gathering to the next at the change-over station with no looping or linking of any sort (Figs 25 and 26a). This results in a somewhat weaker structure at the two ends of the book block, as the total number of connecting points between the gatherings at the change-over stations is divided between the two ends of the book block.

31 Of course, in Islamic bindings, the use of thin silk threads results in very thin 'chains', which therefore need not be recessed in order for the spine of the book to remain smooth.

Fig. 25: Bridge sewing in the change-over stations in codex Sinai, Monē tēs Hagias Aikaterinēs, Gr. 824 (Diktyon 59199).

2.7.5 Linked loops towards the inside

This describes the movement of the sewing thread at the change-over station where the thread exits, drops down to the sewing of the previous gathering, loops around it and, passing under itself, climbs towards the book block (Fig. 26b).[32]

2.7.6 Linked loops towards the outside

This describes the movement of the sewing thread at the change-over station where the thread exits, drops down to the sewing of the previous gathering, loops around it and, passing under itself, climbs away from the book block, towards the edge (Fig. 26c).

There is also the possibility to have the thread pass not under but above itself, though this creates a much looser link between the gatherings, as it lacks

32 This is what Spitzmueller 1982–1983, 44, fig. 4 describes as 'to-the-inside'.

the self-blocking of the thread that occurs when it passes under itself. This might be an extra hint that variation b of the crossed linked-loop stitch described above is probably more sensible than variation a.

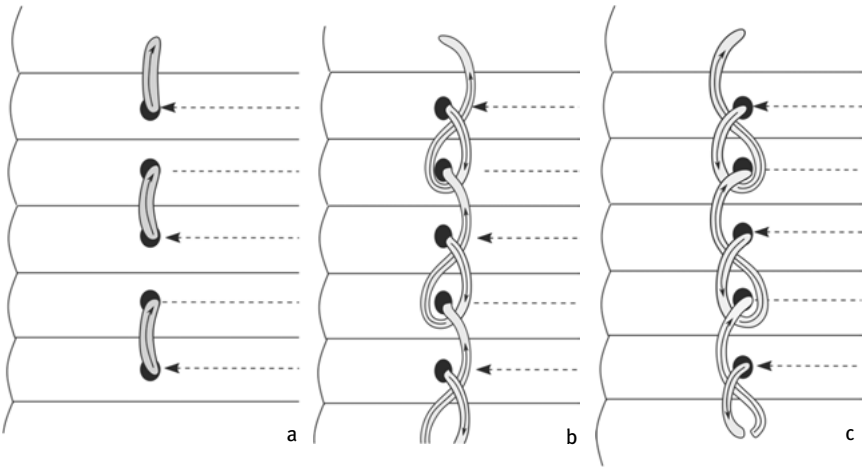


Fig. 26a–c: Bridge sewing (a), linked loops towards the inside (b), and linked loops towards the outside (c).

As a rule, the thread used was either hemp or linen, occasionally surprisingly thick. Unless the number and/or dimensions of the gatherings were small, multiple lengths of thread were used in order to sew all the gatherings in a single book block. Once one thread length was used, another one was added by knotting it to the first. Such knots are occasionally found in the centrefold and rarely the spine of gatherings (see below). Although the thread compressed between the gatherings sometimes looks like it was waxed, there is so far no unambiguous example of the waxing of the sewing thread known to the author.

In practical terms, a curved needle works particularly well for the sewing of the gatherings. We have no direct evidence of the use of such curved needles save for the miniature of Saint Luke on fol. 3^{r} of codex Saint Petersburg, Rossijskaja Nacional'naja biblioteka, F.I.591, written in Serbia in 1429. In the miniature the curved needle is shown among other tools, as well as what may be understood as a straight needle (Fig. 27). The inclusion of needles among the scribe's other tools may also indicate its use in the tacketing of the folios of gatherings, as described above. A thin, straight and rusted needle has been found secured inside the textile board lining of codex Sinai, Monē tēs Hagias

Aikaterinēs, Gr. 1244 (Diktyon 59619), but there is no way to know if this was actually used for sewing the gatherings of the book block or, rather, if it was secured in the textile as a means to prevent its loss. The needle is in fact rather thin to use for the sewing of the codex, although this possibility cannot be excluded. We should also mention here the small sewing needle used to sew the gatherings of codex Paris, Bibliothèque nationale de France, gr. 550 (Diktyon 50126), as mentioned in the rebinding note on fol. 1[r][33] as well as the note on a letter written by monk Frange in Egypt around the seventh to eighth century.[34]

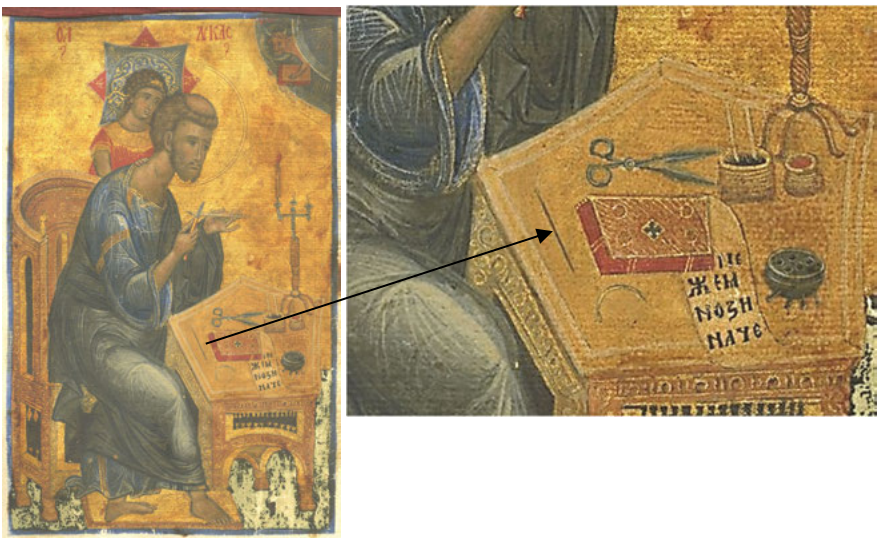


Fig. 27: Saint Luke, fol. 3[r] of codex Saint Petersburg, Rossijskaja Nacional'naja biblioteka, F.I.591; photo from https://nlr.ru/manuscripts/RA1527/elektronnyiy-katalog?ab=8168AAF3-FC6A-4032-9860-8EF24AFBB162 (accessed on 6 February 2023).

33 A 'corrected' version of the note is transcribed in D'Aiuto 1997, 11, n. 19. The note includes some quite intriguing phrases, like τριμαλιάς ραφίδος, which obviously refers to the sewing needle used to sew the gatherings. The word τριμαλιάς is, by all evidence, an incorrect version of τρυμαλιάς (and not a *hapax*, as asserted by Bianconi 2018, 92), referring to either the needle holes or the sewing holes of the gathering. The very words τριμαλιάς ραφίδος allude to the metaphor in the Gospel of Mark in which a rich man's entrance to paradise is compared to a thread passing through the eye of a needle. This note requires further investigation. I am grateful to Elias Tsolakopoulos for clarifying this passage and explaining the reference to the Gospel of Mark.

34 Thebes, Ostracon inv. no. 292238 in Boud'hors 2008, 158, fig. 4. Also mentioned in Boudalis 2018, 49.

One last thing that should be noted here is that in the sewing process, the parchment at the V-shaped openings is sometimes folded by the sewing thread itself, a feature that may allow one to identify the direction of sewing, which in turn may allow for the identification of version a or b of the crossed linked-loop stitch described above (Fig. 28).

Fig. 28: Veria, Dēmosia Kentrikē Bibliothēkē, KB 7 (Diktyon 9603), showing the folding of the parchment, which indicates the direction of the sewing.

2.8 Knots

The knots used to connect two sewing threads together (also referred to as bends)[35] can usually be found in the centrefold of gatherings (Fig. 29), and occasionally also along the spine, although there the presence of adhesive can make identifying the type of knot quite difficult. So far, no attention has been paid to knot types, at least in Byzantine and related bindings, but the few examples recorded by the author indicate that the possibilities were much greater than we would have suspected. Often a knot needs to be totally or partially undone in order to be recorded and subsequently identified, and for these reasons, the ideal conditions for recording them occur when a book block is undergoing conservation. Even if it is not possible to identify their type, the place of the

35 See Ashley 1993, 257–273.

knots should be recorded and, in the case of the resewing and rebinding of a codex, the sewing threads of the original sewing should of course be preserved.

In Fig. 30, eight different knots are shown as recorded in Byzantine bindings. More specifically, a stopper knot was recorded in codex Sinai, Monē tēs Hagias Aikaterinēs, Ar. NF (Fig. 30a); a square knot in codex Thessaloniki, Aristoteleio Panepistēmio, Spoudastērion Philologikēs Scholēs, 81 (Diktyon 63318) and codex Sinai, Monē tēs Hagias Aikaterinēs, Gr. 1122 (Diktyon 59497), in both cases used for the endband tiedowns (Fig. 30b); an unidentified knot in codex Veria, Dēmosia Kentrikē Bibliothēkē, KB 4 (Diktyon 9609) (Fig. 30c); a weaver's knot in codex Athens, Ethnikē Bibliothēkē tēs Hellados (National Library of Greece), 2106 (Diktyon 4138), rebound before 1430 (Fig. 30d); two similar sheet bends in codex Veria, Dēmosia Kentrikē Bibliothēkē, KB 4 (Figs 30e and 30f, the latter much more stable and effective than the former); an unidentified knot in codex Thessaloniki, Mouseio Byzantinou Politismou (Museum of Byzantine Culture), 26 (Diktyon 75180) (Fig. 30g) and a half knot in codex Veria, Dēmosia Kentrikē Bibliothēkē, KB 10 (Diktyon 9606), written in 1511, in its original binding (Fig. 30h).

Fig. 29: Veria, Dēmosia Kentrikē Bibliothēkē, KB 10.

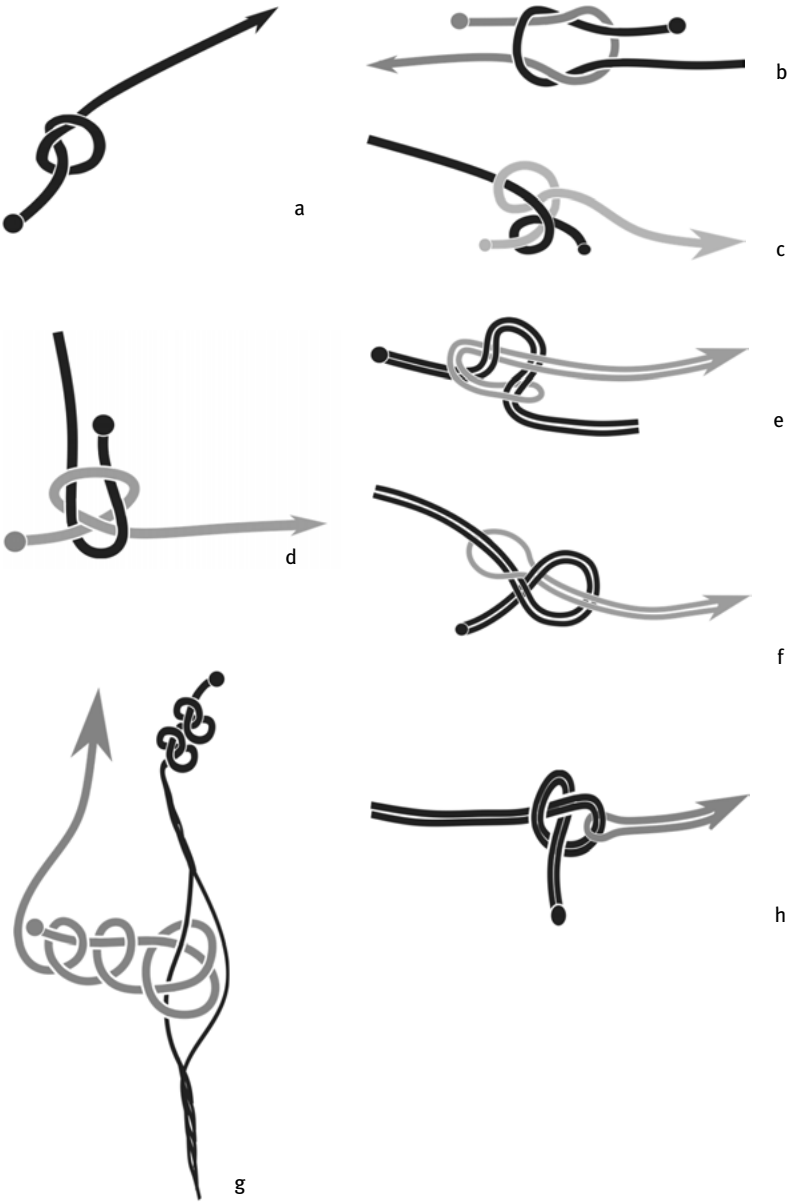


Fig. 30a–h: Eight different knots from Byzantine bindings; a dot indicates the inactive end of the thread/s and an arrow the active one.

2.9 Rounding of the spine

No evidence of the use of a hammer for the rounding of the book block spine has ever been found on any Byzantine or related binding. The natural rounding of the spine and the bending of the gatherings around the spine edge of the boards, as can be seen in many bindings, is usually the result of sewing the gatherings with the boards in one process, using the double-sequence sewing described above. Although one should be cautious about identifying the use of double-sequence sewing without having visual access to the spine of a codex, the presence of the same bending of the outermost gatherings around the spine edge of the two boards of a book should normally indicate the sewing of the book block in two halves.

Occasionally it is possible to find evidence of the flattening of the gatherings' spine – once these were sewn together into a book block – using some hard tool, for example a bone folder. In parchment manuscripts (Fig. 31), especially when thick parchment was used, this process would probably require some moisture, so it was perhaps done after the adhesive to attach the spine lining was applied. The flattening of the spinefolds of the gatherings was easier to make in paper manuscripts, where in fact it is more commonly encountered (Fig. 32).

Fig. 31: Sinai, Monē tēs Hagias Aikaterinēs, Gr. 33 (Diktyon 58408).

Fig. 32: Sinai, Monē tēs Hagias Aikaterinēs, Gr. 1205 (Diktyon 59580).

3 Terminology

The aim of this section is to elaborate on the various terms used to designate and describe the unsupported sewing technique used in Byzantine and related bindings, and to draw attention to the complexities of the issue itself, as different scholars and different professionals use different words and terms to describe the same things and techniques.

Let us start by saying that all terms are to an extent conventional, and they can work perfectly well as long as the people who use them agree on their meaning. So even if one term – for example, 'loop' – may describe the stitch used in unsupported sewing more accurately than the term 'link', both terms can work perfectly well in the context of an agreement between the people using them. Nevertheless, here I shall propose a few new terms for the following reasons:

1. They are consistent with terms used in textile terminology, and thus they support and work towards an integrated terminology between books and textiles whenever this is possible.

2. They are more accurate in structural terms.
3. They enrich and broaden our pool of terms, and therefore allow for a more nuanced description of the sewing of book blocks.

The most consistent attempt to describe the process and terminology of sewing in bookbindings can be found in an article by Pamela Spitzmueller.[36] The author conceives of the sewing of a book block in three levels: the sewing stitch ('the action of sewing as the sequential combination of a limited number of distinct motions';[37] in other words, the sewing process); the sewing pattern ('the built-up design of the sewing thread as it unites the sections into a text block');[38] and finally, the sewing structure (i.e. essentially supported or unsupported). Spitzmueller's vocabulary to describe the sewing of a book block comprises fourteen terms, of which about half are relevant for the unsupported sewing structures discussed here.

In Spitzmueller's terminology, the term 'sewing stitch' can indicate both the process as well as the particular type of stitch used, such as overcasting, running stitch, backstitch, link-stitch and chain-stitch, to limit ourselves specifically to those used in bookbinding. To avoid confusion, I shall use the phrase 'sewing process' to describe exactly this (therefore not using stitch as a verb), and reserve the term 'sewing stitch' for the specific types of stitches used.

When dealing with unsupported sewing structures, the type of stitch used has been variably described as a chain-stitch, link-stitch and recently as a loop stitch. Let us look more closely at these terms.

3.1 Chain-stitch

The term 'chain-stitch' has a rather long history in bookbinding literature and in languages other than English.[39] The term's use derives from the visual similarity between the built-up pattern of the consecutive stitches along the sewing stations in the spine of a book block and metal chains. In fact, Spitzmueller calls this a chain or link pattern.[40]

36 Spitzmueller 1982–1983, 44–46.
37 Spitzmueller 1982–1983, 45.
38 Spitzmueller 1982–1983, 45.
39 In German, it is called *Kettenstich*; French, *couture à chaînette*; Greek, ραφή τύπου αλυσίδας; Italian, *cucitura a catenella* and Spanish, *cadeneta*.
40 Spitzmueller 1982–1983, 45.

The *Language of Bindings Thesaurus* (hereafter *LOB*) defines a chain-stitch as follows:

> A type of unsupported sewing in which the sewing thread, as it emerges from an individual sewing station, is taken down and round the thread emerging from the same station in the previous gathering(s), forming linked chains of thread across the spine. Chain-stitch can be found on both supported and unsupported structures.[41]

In the *LOB*, 'link-stitch' and 'link-stitch' are proposed as alternative terms.

A chain-stitch is a common stitch in embroidery, where it consists of a sequence of loops linked together on the vertical axis, as shown in Fig. 33.[42] As explained elsewhere,

> Chain-stitch [...] does provide some visual similarity to the actual sewing technique used for the codices we are considering here, but the similarity is only superficial and visual, not structural or functional. As a rule, chain-stitch is used on already made fabric, and its purpose is decorative rather than structural, to embellish rather than create a fabric.[43]

Similarly, the 'chain' in nalbinding (Fig. 34),[44] sinnets[45] and crochet (Fig. 35) consists of a series of loops linked together on the vertical axis, although unlike in embroidery, here the process actually creates a fabric rather than just embellishing it. Again, the similarity between the chains in these techniques and the stitch used in the sewing of codices is only visual, not structural.[46] Chains are also very common in jewellery, and some of them are visually very close to the sewing we consider here, especially the wheat or spiga chain and the fox-tail chain (Fig. 36).[47]

The visual (and only to some extent structural) similarities between these different 'chains' are sometimes striking, and in fact it was these visual similarities that led to the author's research in textiles as the ultimate source of the sewing technique used in unsupported sewing structures.

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41 https://www.ligatus.org.uk/lob/concept/1249 (accessed on 10 December 2022).

42 On chain-stitch, see also https://trc-leiden.nl/trc-needles/techniques/embroidery/embroidery-stitches/chain-stitch. See also https://trc-leiden.nl/trc-needles/techniques/embroidery/embroidery-stitches/twisted-chain-stitch (accessed on 10 December 2022).

43 Boudalis 2018, 53.

44 See Claßen-Büttner 2015, 12–16. See also Hald 1980, 292.

45 See Ashley 1993, 471–473.

46 See also https://trc-leiden.nl/trc-needles/techniques/looping/chain (accessed on 10 December 2022).

47 On chains and their terminology, see e.g. https://thechainhut.co.uk/necklace-chain-style-type-guide (accessed on 10 December 2022).

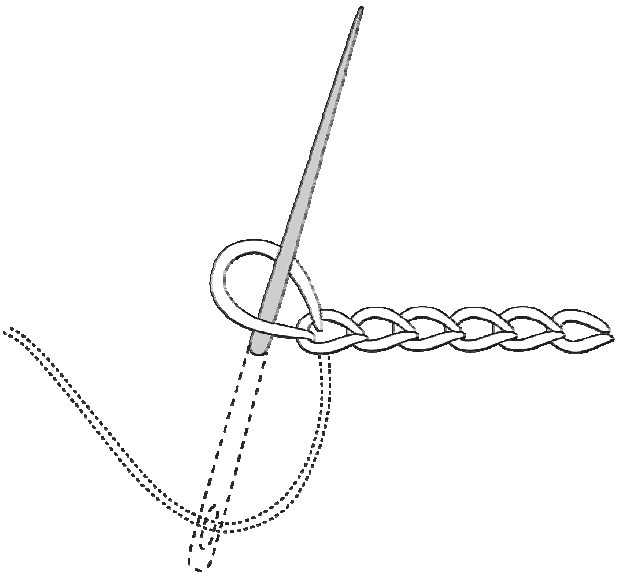

Fig. 33: Chain-stitch in embroidery.

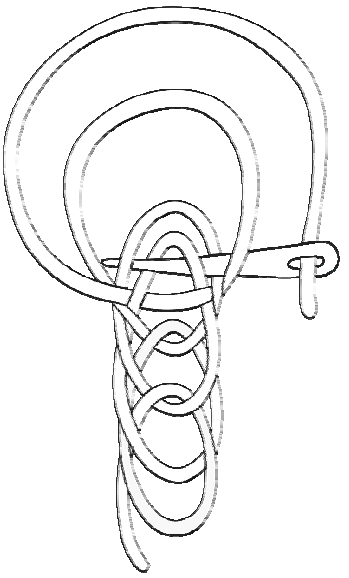

Fig. 34: Chain-stitch in nalbinding. Drawing adapted from Hald 1980, fig. 326.

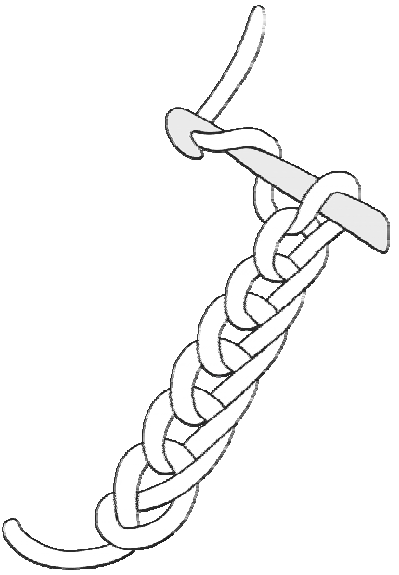

Fig. 35: Chain-stitch in crochet. Drawing adapted from https://trc-leiden.nl/trc-needles/techniques/looping/chain.

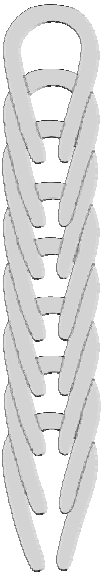

Fig. 36: Metal fox-tail chain. Drawing adapted from https://www.cgtrader.com/3d-print-models/jewelry/necklaces/double-loop-in-loop-chain.

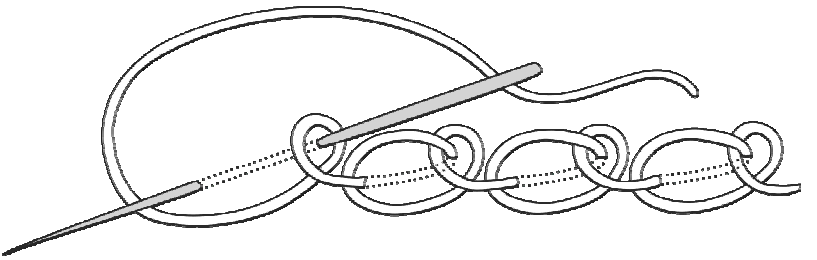

Fig. 37: Drawing showing what, in textile terminology, is called a link-stitch. Based on https://www.needlenthread.com/2013/08/stitch-fun-knotted-chain-stitch.html.

3.2 Link-stitch

Spitzmueller uses the term 'link' or 'linking' to describe the situation in which one thread catches another thread (although, in unsupported sewing, this other thread is in fact the same thread, only used in the previous gathering/s) before continuing in the sewing process. Her definition is broad and applies to all types of sewing stitches in which one thread passes under another thread exiting from another gathering (see her drawings in Figs 1–2 in her article, all three showing different types of stitches), and quite significantly, she does not use the term 'link-stitch'.

In the *LOB*, 'link-stitch' or 'link-stitch' is used as a synonymous or alternative term for 'chain-stitch'. Instead, the term 'linking' describes a completely different technique.[48]

The link-stitch as described by the Textile Research Centre is a different stitch still, similar to a chain-stitch.[49] More specifically, in textile terminology, a

48 'A technique in which a length of thread is wound across the spine of the book a) around the individual tiedowns or groups of tiedowns of an endband or b) the sets of thread of a long-stitch binding after the sewing was completed. It could be done with the end of the thread with which an endband was sewn, either just below the core or at the point where the tiedowns emerge from the spine, often at the height of the changeover station. Linking stitches on long-stitch sets can be found at one or both ends of each set, but only one end of one set can be sewn with the thread used to sew the book. The other, or often both, linking stitches will be sewn in a variety of styles with separate lengths of thread'. See *LOB*, *s.v.* 'linking stitch': https://www.ligatus.org.uk/lob/search?search_api_fulltext=Linking (accessed on 10 December 2022).

link-stitch, like a chain-stitch, is an embellishment stitch, i.e. it is used to decorate a fabric. In textile terminology, linking is related to single element structures, i.e. structures produced by a single continuous thread, in fact like the sewing structure of a codex.[50]

3.3 Linked-loop stitch

Due to the fact that the sewing in the main sewing stations of these bindings essentially consists of loops around other loops,[51] I have previously proposed that we use the term 'loop stitch' to describe the specific sewing stitch used for unsupported sewing structures.[52] The reason behind this is, first, the fact that 'link-stitch' is a broad term that does not accurately describe the stitch used in these bindings, and also because this and 'chain-stitch' have a different meaning and function (decorative rather than structural) in textile technology and terminology. Furthermore, as has been previously explained, the sewing technique used in unsupported sewing structures is an adaptation of a so-called looping technique, as it is based precisely on the construction of a fabric by loops looped around other loops, or in other words, by linked loops both on the horizontal and vertical axes (Fig. 38).

Considering the above, a sensible and a more accurate alternative for the terms 'chain-stitch' and 'link-stitch', as they have been applied in bookbinding terminology, could be the term 'linked-loop stitch'.

49 'A link stitch is a composite stitch used to create a decorative line. It consists of chain-stitches that are worked as a knot, and linked to the next chain-stitch with a simple straight stitch. The link stitch is also known as a knotted chain-stitch'. See https://trc-leiden.nl/trc-needles/techniques/embroidery/embroidery-stitches/link-stitch (accessed on 10 December 2022).

50 On linking, see also Seiler-Baldinger 1994, 7–9.

51 This is how Emery (1994, 45) defines the use of the word 'loop': 'It is generally agreed that the word loop suggests the curved enclosing boundary of a space, and the idea of looping something over or round something else so that a loose fastening is formed'.

52 See Boudalis 2018, 52.

Fig. 38: A composite image showing (in the background) the 'chains' of a sock made with cross-knit looping, and (in the foreground) those formed in the unsupported sewing of codex gatherings, manipulated in Photoshop to show them as closely spaced.

4 Discussion and conclusions

Despite the fact we now have a much clearer understanding of the technology and variations of the unsupported sewing structures of codices, there are still things that have thus far escaped our attention and understanding. One example is the different types of knots used in the sewing process. It is also important to be prepared to observe and identify techniques and variations that have not been recorded before, as in the example of the open linked-loop stitch recorded in Syriac bindings. To this end, the role of book conservators is of primary importance, as it is usually only in cases in which bound codices undergo conservation treatment that such technical details can be studied and recorded. Besides the conservation of codices themselves, this is in fact one of the positive side effects of bench work, and book conservators should be prepared to be able to observe, understand, and record such details.

The terminology we use for bookbinding processes such as the sewing of a book block should evolve and follow the evolution of our understanding and knowledge of the subject. In the specific case of the sewing of the gatherings of a codex into a book block, and following its close relation to fabric-making techniques, I believe that we should try to adopt and adapt the terms used in textile terminology, especially given the fact that research in this field is older, wider and richer than research in bookbinding techniques.

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